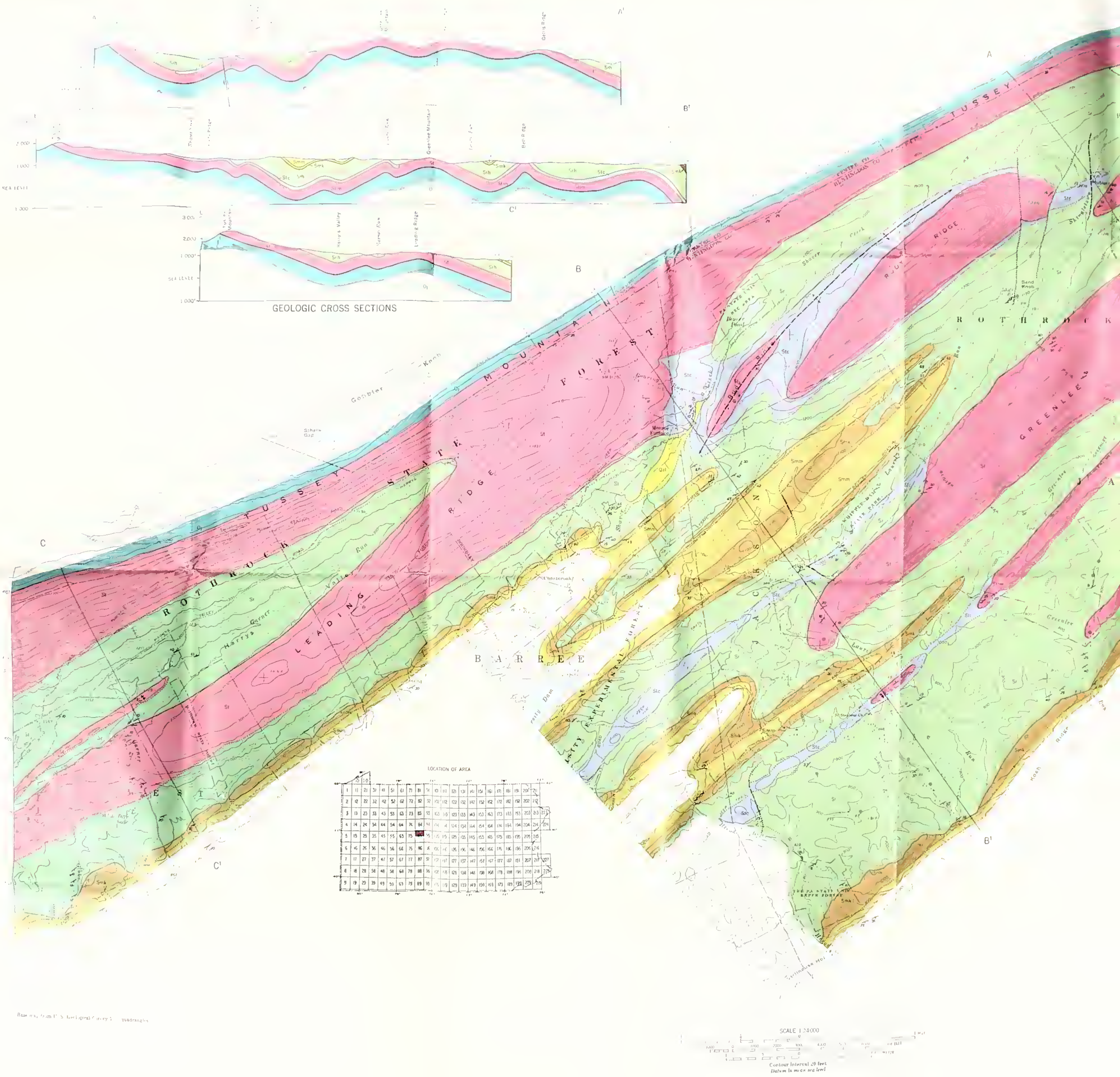
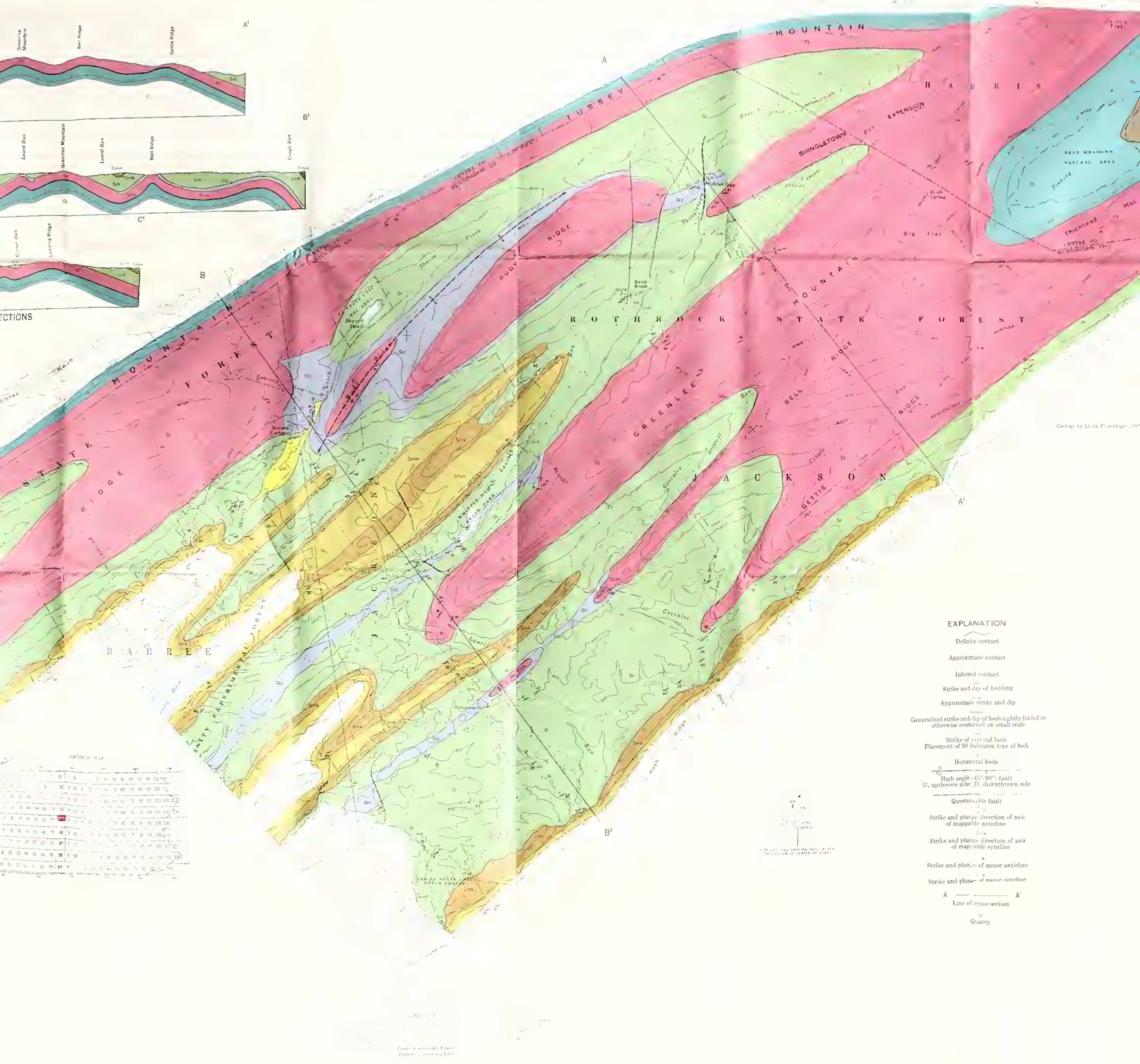


GEOLOGIC CROSS SECTIONS

Base map from U. S. Geological Survey [illegible] quadrangle

GEOLOGY OF A PORTION OF THE ALLENSVILLE QUADRANGLE, CENTRE AND HUNTINGDON COUNTIES, PENNSYLVANIA

by
Linda A. Flueckinger
1969



GEOLOGY OF A PORTION OF THE ALLENSVILLE QUADRANGLE, CENTRE AND HUNTINGDON COUNTIES, PENNSYLVANIA

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1969

TOPOGRAPHIC AND GEOLOGIC SURVEY
Arthur A. Socolow, Director

Geology of a Portion of the Allensville Quadrangle, Centre and Huntingdon Counties, Pennsylvania

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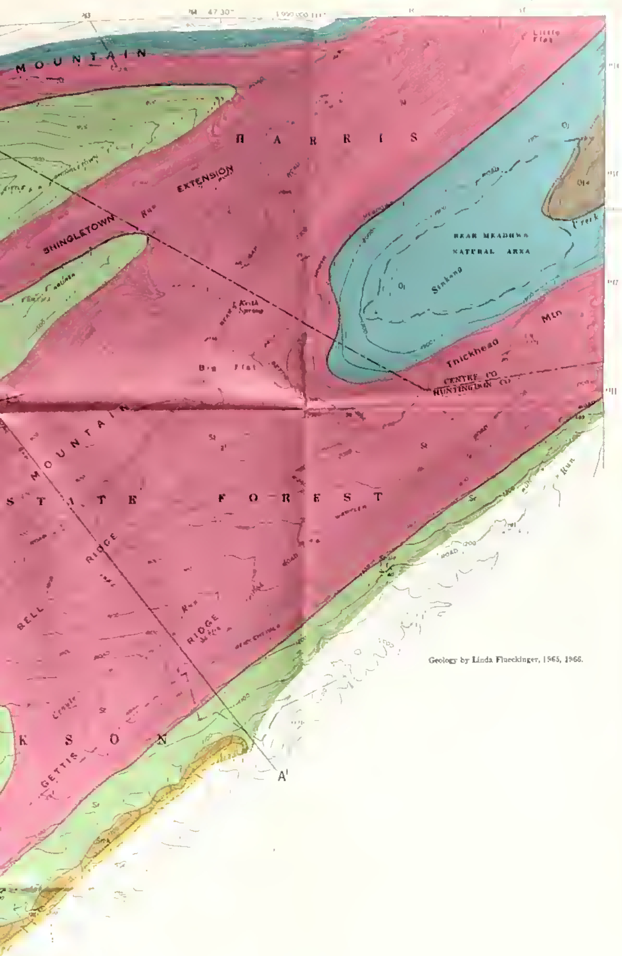

Geology by Linda Flueckinger, 1965, 1966.

EXPLANATION

Definite contact

Approximate contact

Inferred contact

Strike and dip of bedding

Approximate strike and dip

Generalized strike and dip of beds tightly folded or otherwise contorted on small scale

Strike of vertical beds
Placement of 90 indicates tops of beds

Horizontal beds

High angle (45°–90°) fault
U, upthrown side, D, downthrown side

Questionable fault

Strike and plunge direction of axis of mappable anticline

Strike and plunge direction of axis of mappable syncline

Strike and plunge of minor anticline

Strike and plunge of minor syncline

A — A'
Line of cross section

SYSTEM	SERIES	MAP UNIT	MAP SYMBOL	LITHOLOGY (Scale 1" = 150')	THICKNESS (feet)	DESCRIPTION
		Alluvium	Qal		±50	
SILURIAN	Middle Silurian	Mifflintown Formation: Rochester and McKenzie Members	Smm		±350	Mifflintown Formation Rochester and McKenzie Members The Rochester and McKenzie Members have been mapped together because of the difficulty of separating them in the field. Observed mainly as float in lowland valleys and in excavations with younger McKenzie Member occurring primarily in the center of synclines. Mainly light olive gray (5Y6/1) shale and pale yellowish brown (10YR6/2) to dark yellowish brown (10YR4/2) micaceous shale and siltstone interbedded with medium gray (N5) to dark gray (N3), fine to medium crystalline limestones with calcite veinlets and abundant fossils, mainly brachiopods and ostracodes. Pale red (5R6/2) calcareous and silty shales and mudstones and grayish red (5R4/2) fine grained sandstone and siltstone occur as float and outcrop at two locations in centers of synclines. In the field area, direct or indirect measurements of these units could not be made because of poor control and structural complications. The estimated thickness is 350 feet for the combined members.
		Mifflintown Formation: Keefer Member	Smk		±50	Keefer Member The Keefer Member is underlain with gradational contact by the Rose Hill Formation and overlain by the Rochester Member of the Mifflintown Formation. Light gray (N7), fine grained, limonite speckled, fossiliferous, thin- to thick-bedded quartzitic sandstone. Contains thin bedded, light bluish gray (5B7/1) and some grayish-red (5R5/2) layers of coarsely crystalline, highly fossiliferous limestones and oolitic hematite. Distinctive because of weathering into moderate yellowish-brown, deeply pitted fragments in which brachiopods and crinoid stem plates have weathered out and are sometimes replaced by coarsely crystalline calcite. Exposed on a thin ridge between less resistant shales with upper contact sharply defined. Best exposures at Globe Run, Greenlee Run near southern edge and along Highway 26. The Keefer Member is approximately 50± feet in thickness in the mapped area, but tends to form a relatively wide outcrop pattern at the surface where the overlying shales of the Rochester Member have been stripped off the dip slope of the resistant Keefer sandstones.
	Lower Silurian	Rose Hill Formation	Srh		±800	Rose Hill Formation Olive gray (5Y3/2) fossiliferous shales weathering pale yellowish-brown. Pale red (5R6/2) and micaceous shales present near lower contact with Castanea Member. Interbedded with 1- to 3-inch layers of medium light-gray (N6) fine- to very fine grained, well indurated quartzitic sandstones weathering moderate brown (5YR4/4) and 1- to 2-inch beds of medium dark-gray (N4), coarsely crystalline, highly fossiliferous limestone associated with 1-inch beds of olive-gray (5Y7/1) and medium bluish-gray (5R5/1) calcareous siltstone. Brachiopods *Coelospira hemispherica* and *Stegerhyncus neglecta* present at several localities. Locally contorted with well-developed fracture cleavage resulting in pencil-like weathering fragments up to 1 foot in length. Poorly exposed except for stream cuts such as Globe Run at the western edge and shale pits at Sand Knob and southeast of Gettis Ridge along Beidleheimer Road. The thickness of the Rose Hill Formation could not be measured directly in the field area because of the absence of complete sections. Thicknesses of 771 and 880 feet were calculated for the Rose Hill Formation from locations in the map area where reasonable control was present.
		Tuscarora Formation (St): Castanea Member (Upper Member)	Stc		±100	Tuscarora Formation In the study area, the Tuscarora Formation is composed of two members: white, resistant quartzitic sandstones making up the bulk of the formation, and a thinner upper series of predominantly red and green sandstones. These red and green sandstones are referred to as the Castanea Formation by F. M. Swartz. Since it is not possible to map them separately at all occurrences, in this study, the Castanea is considered to be the upper member of the Tuscarora Formation. Castanea Member Two uniform and distinctive marker horizons of 1-inch to 3-foot beds of blackish-red (5R2/2), fine-grained, very dense and resistant iron-cemented sandstone weathering to very dusky red (10R2/2) and highly fractured. Forms small ledges on down-dip sides of Tuscarora anticlinal ridges. In some places, such as the exposure at Whipple Dam State Park, 1- to 6-inch beds of ferruginous sandstones with ripple marks exposed on bedding planes are interlayered with highly iron stained, pale yellowish-brown (10YR6/2) silty shale and 1- to 6-inch beds of olive gray (5Y3/2), very fine grained sandstone. Moderate yellowish-brown shale float is often found associated with iron sandstone float. Iron-cemented sandstones separate 35± foot upper unit, 35± foot central unit and thinner lower unit grading into Lower and Middle Members of Tuscarora Formation. Main units thin to medium bedded, light olive gray (5Y5/2), fine- to very fine grained, limonite-speckled and micaceous sandstones with irregular laminations and patches of more resistant siltstone and interlayers of olive-green (5Y4/1) siltstone and shale and medium beds of pale red (10R6/2) to grayish-red (5R4/2) very fine grained micaceous sandstone especially in the central and lower units. *Arthrophycus alleghenensis* present at some localities. Relatively complete section of nearly horizontal beds exposed discontinuously up the slope from Shaver Creek to Highway 26 at Monroe Furnace. Iron-cemented sandstones occur in the Tyrone and Bellefonte quadrangles as part of the Rose Hill Formation. In the southeastern Seven Mountains District a 3 foot, iron-cemented sandstone bed occurs in the Castanea Member. F. M. Swartz (personal communication) is in accord that, in the study area, the Castanea consists of two ferruginous sandstone units with an intermediate series of green sandstones, siltstones, and shales between shales of the Rose Hill Formation and white quartzites of the Tuscarora Formation.
		Tuscarora Formation (St): Lower and Middle Members	Stlm		±450	Lower and Middle Members. No complete exposures present; best exposures located along ridge tops and in streams valleys. Pure white (N9) or very light-gray (N8) fine- to very coarse grained, hard and resistant, thoroughly silica-cemented, limonite speckled, quartzitic sandstone. Bedding thickness from 2 to 4 inches up to 6 inches to 3 feet. Cross-bedding ranges from laminations to festoon type 6 to 18 inches long all observed dipping to northwest. Red sandstone concretions and hemispherical depressions on bedding surfaces such as in stream outcrop northeast of Sand Knob Trail on northwest side of Greenlee Mountain. *Arthrophycus alleghenensis* common on bottoms of beds. Weathers into very pale orange (10YR8/2) to grayish pink (5R8/2) blocky fragments up to 10 feet with pitted surfaces and weathering rinds. Some thin interbedded layers of olive-gray shale on crests of Leading Ridge and in folds at Laurel Run near St. Stephens Church. The thickness of the Tuscarora Formation cannot be measured directly due to lack of exposure. Calculation of thickness from outcrop width is possible only along Tussey Mountain which has a homoclinal dip in contrast to the four other major ridges which are underlain by anticlinal structures. The average thickness calculated for the section underlying Tussey Mountain in the McAlevy's Fort quadrangle is 550 feet.
ORDOVICIAN	Upper Ordovician	Juniata Formation	Oj		±1600	Juniata Formation Observed only as float; upper and lower contacts not exposed. Red, limonite speckled sandstone with some interlayered red silty shale, red mudstone in lower and middle portions and 200 feet hard and resistant pale red (5R6/2) to grayish red (5R4/2) fine grained blocky weathering resistant sandstone in the upper part. Less resistant beds form topographic depression between ridge-forming Bald Eagle and Tuscarora Formations. Erosion of Juniata Formation in nose of southwest plunging Bear Meadows anticline forms U-shaped depression containing entire Bear Meadows Natural Area, a northern, high level peat bog.
		Bald Eagle Formation	Obe		±500	Bald Eagle Formation Present only as float in Bear Meadows anticline. Olive-gray (5Y4/1), fine- to medium-grained, limonite-speckled, impure sandstone containing recognizable fragments of feldspar, mica, and clay materials. Weathers to pale yellowish brown (10R6/2) blocky fragments. Dark reddish-brown (10R3/4) and pale red (10R6/2) resistant conglomerate and conglomeratic sandstones with shale chips, metamorphic rock fragments and predominantly fractured white quartz pebbles up to ½ inch in maximum dimension at upper contact with Juniata Formation. This conglomeratic unit appears to be equivalent to the red and green, cross bedded conglomerate and conglomeratic sandstones designated as the "Lost Run Conglomerate" by F. M. Swartz from exposures at Lost Run Gap in Shade Mountain, Mifflin County, Pennsylvania, or "Oneida Conglomerate" by geologists of the Second Pennsylvania Geologic Survey. Upper contact with Juniata Formation not exposed.

INTRODUCTION

The geology of a portion of the Allensville 15' quadrangle involves strongly folded formations which range in age from Late Ordovician to Middle Silurian. The purpose of this investigation was to map these formations in order to define their geologic and structural relationships and to investigate the origin of the map pattern of the Tuscarora Formation shown on the Geologic Map of Pennsylvania (Gray, and others, 1960). On this map, the Tuscarora Formation is shown as isolated patches rather than in the continuous ridge forming pattern characteristic of the Tuscarora Formation in other areas of the Folded Appalachians.

The stratigraphic sequence of approximately 4,000 feet consists almost entirely of unmetamorphosed detrital sedimentary rock, with the exception of some limestones observed primarily as float. The rock types observed include conglomerate, quartzite sandstone, siltstone, shale, and limestone. Approximately 50 percent of the section consists of quartzite and sandstone, 25 percent shale, 15 percent siltstone, 5 percent conglomerate, and 5 percent limestone.

LOCATION AND TOPOGRAPHY

The area studied is located in central Pennsylvania, 15 miles southeast of State College in Barree and Jackson Townships. It includes approximately 55 square miles trending northeast-southwest with a maximum length of 14.3 miles and a width of 1.5 to 6.0 miles.

The mapped area is situated at the northeastern end of the southwestward plunging Broad Top synclinorium where Ordovician and Silurian rocks reach the surface, and on the southeastern flank of the Nittany Arch.

The major landforms of the mapped area comprise five prominent, subparallel ridges which are separated by valleys. The ridges trend northeast-southwest and are continuous with the exception of the belt of minor ridges parallel to Tussey Mountain on the southeast which is composed of three en echelon segments including Leading and Rudy Ridges. Tussey Mountain is the highest and most extensive ridge, continuing along the entire northwestern boundary. Greenlee Mountain, Bell Ridge, and Gettis Ridge decrease in elevation to the southwest. Rudy Ridge and Greenlee Mountain are double crested ridges and each has a subsidiary ridge and intervening valley on the northwestern side.

The ridges are partially convergent near the northeastern corner of the area where they form the uplands referred to as Little Flat and Big Flat. These flats partially surround a U-shaped topographic depression containing a northern, high level peat bog called the Bear Meadows Natural Area.

Inactive mantles of sandstone scree extensively cover the crests of the five major ridges, their adjoining slopes, and to a lesser extent the intervening valleys. This debris is composed of angular blocks of Tuscarora quartzitic sandstone up to 10 feet in longest dimension. In some cases, the parent outcrop can be identified along the ridge tops, but generally, most source areas are buried by scree. The weathered condition of the scree blocks appears to indicate that these fragments are stable and that the scree deposits are largely inactive. The scree deposits occur in a variety of configurations and are attributed to periglacial origin (Hodgson, 1967).

The mapped area is composed of two topographic domains with contrasting elevation and relief. The lowest elevations and smallest local relief occur in the area southwest of State Highway 26 and southeast of the Stone Valley Road from Monroe Furnace to the southwestern edge of the area. The most common local relief in this area is 300 feet, with the least local relief occurring along Laurel Run and Shaver Creek. The highest elevations and maximum relief occur between the main ridges and valleys and in places where streams cut across ridges. Relief is 300 to 500 feet along these points. The maximum local relief of 540 feet occurs between Greenlee Mountain and Greenlee Run near Owl Gap Trail.

The highest elevation of 2,400 feet occurs at Big Flat and Little Flat. The lowest elevation of 740 feet occurs along Herod Run in the southern corner of the area. The maximum total relief in the map area is 1,660 feet.

The classical relationship between resistance of rock units to weathering and surface elevations in the Valley and Ridge province is clearly shown in the mapped area. The five major ridges are all underlain by resistant, well-cemented quartzite beds of the Tuscarora Formation. Subsidiary ridges at lower elevations are maintained by thinner sandstone units including the Keefer Member and intraformational iron-rich sandstone. Valleys and lowland areas are developed on shales and limestones except where streams have cut across resistant ridges.

With one exception, there is a direct relationship between anticlinal and synclinal folds and the resulting topographic forms of the area. The exception to this relationship is found in the synclinal ridge between Greenlee Mountain and Bell Ridge, immediately northeast of Highway 26 where resistant sandstone beds of the Keefer Member of the Mifflintown Formation are exposed in the core of a plunging syncline.

PREVIOUS INVESTIGATIONS

The area was mapped previously by Alexander McKinley of the First Pennsylvania Geological Survey under the direction of H. D. Rogers and later by C. E. Billin of the Second Geological Survey of Pennsylvania. These early reconnaissance investigations represent correct interpretations of the general structural relations even though they were conducted at a large scale and primarily to show the distribution of iron ore deposits.

The area between 77°45'-77°55' west longitude and 40°42'30"-40°40' north latitude was mapped on a scale of 1:25,000 by P. C. Wilson (1950).

The geology of a 2 mile wide strip along the southwestern edge of the area was compiled by Dorf (1959) from mapping on a scale of 1:62,500 by students at the Mineral Industries Summer Camp of Pennsylvania State University during the summers of 1953-1956.

Field work for the present study was completed during 1965 and 1966.

STRUCTURAL GEOLOGY

The formations have been deformed by concentric folding into a hierarchy of northeast-southwest trending structures. These fold structures, with few exceptions, are symmetrical and continuous throughout the area. Fold axes (crestal lines) are parallel and plunge to the southwest at less than 5 degrees. Five major anticlinal axes are present within the area (see tectonic map). These are from south to north, the Gettis Ridge anticline, the Bear Meadows anticline, (the Bell Ridge anticline) the Greenlee Mountain anticline, the secondary Whipples anticline parallel to it, and the group of right-handed, elliptical, en echelon anticlines between Greenlee and Tussey Mountains. The axis or crestal line of the folds is defined by the crest of the ridges on the assumption that the change in slope along the crest corresponds to the change in dip direction of beds in the Tuscarora Formation.

The anticlines underlying Greenlee Mountain, Bell Ridge, and Gettis Ridge plunge 2 to 4 degrees southwest, assuming that the topographic slope along the crest of the ridge approximates the plunge of the folds. A series of doubly plunging anticlines, oblique to the main structural trend, underlie Rudy Ridge, the northwest extension of Rudy Ridge, and Leading Ridge. The structure northwest of Leading Ridge terminating near Garner Run appears to plunge northeast and may represent part of another doubly plunging anticline. Dip readings at Hubler Gap indicate a plunge increasing from 20 to 70 degrees northeast along the nose of the Rudy Ridge anticline.

The form of the doubly-plunging anticlines can be observed in the topography developed on resistant Tuscarora quartzite layers which have not been breached by erosion. Younger beds are present at the surface on all sides, resulting in isolated lenticular patches of the lower and middle members of the Tuscarora Formation on the map pattern.

The maximum and minimum wave lengths of folding are 2 miles to 1 foot with several intervening orders of magnitude. Each formation has a characteristic wave length of folding except the Tuscarora Formation which contains folds of 3 different orders of magnitude. The smallest and most unusual of these structures are outcrop size folds [illegible] with wave lengths measured in tens of feet have been observed in the quartzites of the Tuscarora Formation at five localities along the crests of anticlines and are particularly well exposed for study at two localities: the southwest side of the gap cut by Laurel Run through Bell Ridge, and the northeast side of the gap cut by Garner Run through the Harry's Valley anticline.

The most complete and least disturbed structures consist of two anticlines exposed discontinuously for 50 to 60 feet on the southwest side of the nearly vertical gap cut by Laurel Run through the southeast extension of Bell Ridge. The wave length of the folds is approximately 30 feet and their axes plunge to the southwest at less than 10 degrees. The hinge lines of these folds strike N. 45 E. and both structures are asymmetric with the northwest limb dipping more steeply (50 to 75 degrees) than the southwest limb (27 to 50 degrees).

Major faults are apparently absent. Minor faults which cut across ridges and offset competent formations have been noted at four localities. They are associated with the Castanea Member of the Tuscarora Formation where it occurs in the cores of anticlines southwest of Whipple Dam State Park, in the extension of the Bell Ridge anticline near the southeastern edge of the field area, and at Hubler Gap. A fourth structure of the same type offsets the Keefer Member of the Mifflintown Formation in the syncline southeast of Rudy Ridge. The offset occurs near the terminations of ridges where the Castanea or Keefer Members plunge beneath the surface, with the exception of the fault southwest of Whipple Dam which cuts across a section of an anticline in the Castanea sandstone where the outcrop pattern is the narrowest. The direction of displacement is left lateral in all cases along north-northwest-south-southeast to northwest-southeast trending fractures with 500 to 3,000 feet of offset. The amount of displacement on Bell Ridge is somewhat questionable since the thickness of the section appears to be doubled on the southwest side of the displacement. These offsets are not traceable into the formations bordering the sandstones and therefore, appear to die out in the adjacent, incompetent shale and limestone units.

These structures are interpreted as small scale tear faults across anticlines resulting from differential advance of adjoining segments of the fold arc, or more likely, as tears between blocks which are more tightly compressed than in other blocks.

The continuous northeast plunge of the Rudy Ridge anticline is broken into a series of segments of differing trends, suggesting a system of periantclinal faults. These faults were mapped on the basis of float distribution and topography, supported by limited outcrop data.

A fault system of this kind, where successive segments are down dropped along the plunge of the fold, is the antithesis of classical periantclinal structures in which most segments have been down faulted toward the culmination point. According to deSitter (1964, p. 193) all of the faults which accompany nearly every anticlinal structure "have a common origin in the stretching that results from the three dimensional shape produced by uplift. Tension parallel to the fold axis occurs because the low points of the axis remain fixed in place, unlike synclinal axes, which are crowded closer together as folding progresses." In this tectonic setting, the faults under consideration are most likely normal faults where the fault planes have relatively steep attitudes.

A southeast dipping thrust fault with a displacement of a few feet cuts through the southeast limb and crest of the anticline exposed southwest of the lake at Whipple Dam State Park.

A fault is indicated northwest of Greenlee Mountain by Wilson (1950, p. 52-54), and has also been reported on the Geologic Map of Pennsylvania (Gray and others, 1960). According to Wilson, a high angle, southeastward dipping thrust fault nearly parallels the strike of the anticlinal axis of the Greenlee anticline for at least 7 miles, causing a doubling of the Tuscarora section. He cites the double ridge topography and distribution of different size float fragments as the chief evidence for this fault, since no bedrock or breccia is exposed along the extent of the inferred fault zone. Meager field data from the present study indicate that the double topographic ridge is probably underlain by a double crested anticline of the type often observed in central Pennsylvania. This interpretation is supported by the presence of younger Castanea sandstone float in the valley between the two ridges. Neither a southeastward dipping thrust fault or a normal fault provides solutions in cross section to account for the doubling of the thickness of the Tuscarora Formation along Greenlee Mountain.

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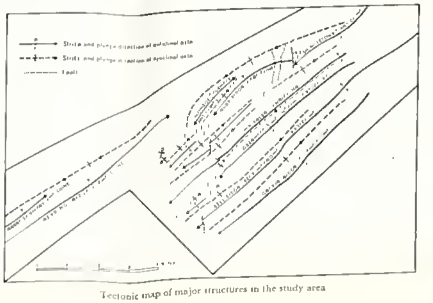
Strike and plunge direction of anticlinal axis
Strike and plunge direction of synclinal axis
Fault

Tectonic map of major structures in the study area